

SAN ANTONIO  
**SIGGRAPH**  
≡2002≡

## **Recreating the Past**

**Alan Chalmers**

**Kate Devlin**

**Paul Debevec**

**Philippe**

**Martinez**



# Creating the Models



**Paul Debevec**  
USC Institute for  
Creative Technologies

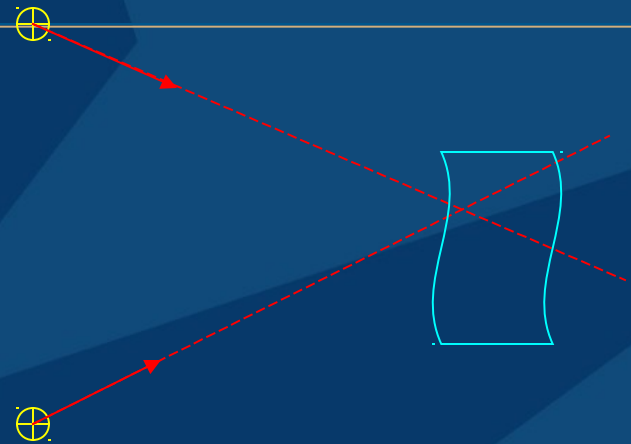
**Philippe  
Martinez**  
Ecole Normale  
Supérieure

# 3D Scanning Overview

- **Scanning determines 3d location of surface points**
- **Two general methods:**
  - Triangulation
  - Time of Flight

# Triangulation

- Two known positions
  - Find direction to a point
  - Intersect line segments
- 
- **Human depth perception**
  - **Measures direction**
  - **Occlusion problems**





# Time of Flight

- **Send out a signal pulse**

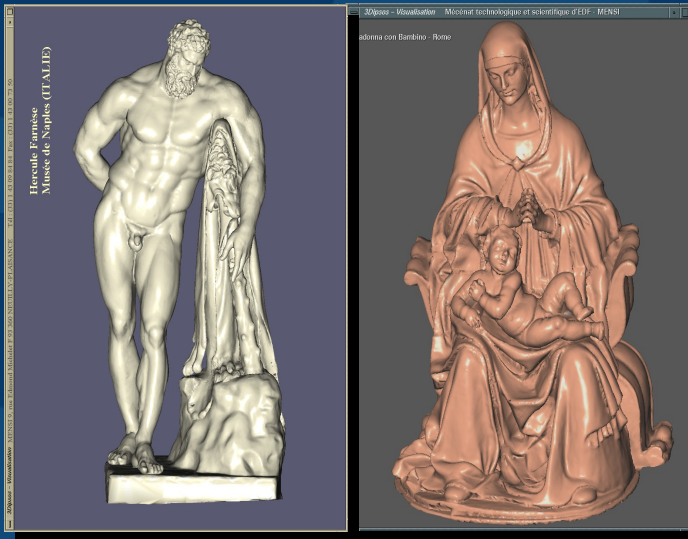


- **Measure time for reflection to return**



- **Measures time**
- **No occlusion**

# Recent 3D Scanning Projects



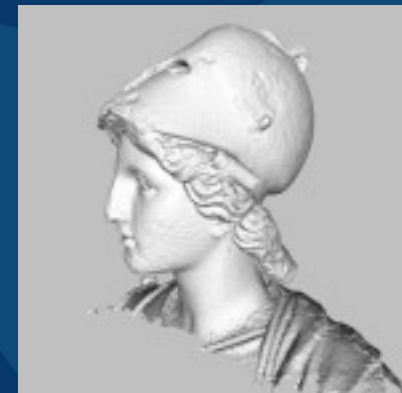
**Electricite de France**



**IBM Watson**



**Stanford  
University**



**CNR Pisa**

# Low-cost, high speed, sculpture scanner - structured light approach



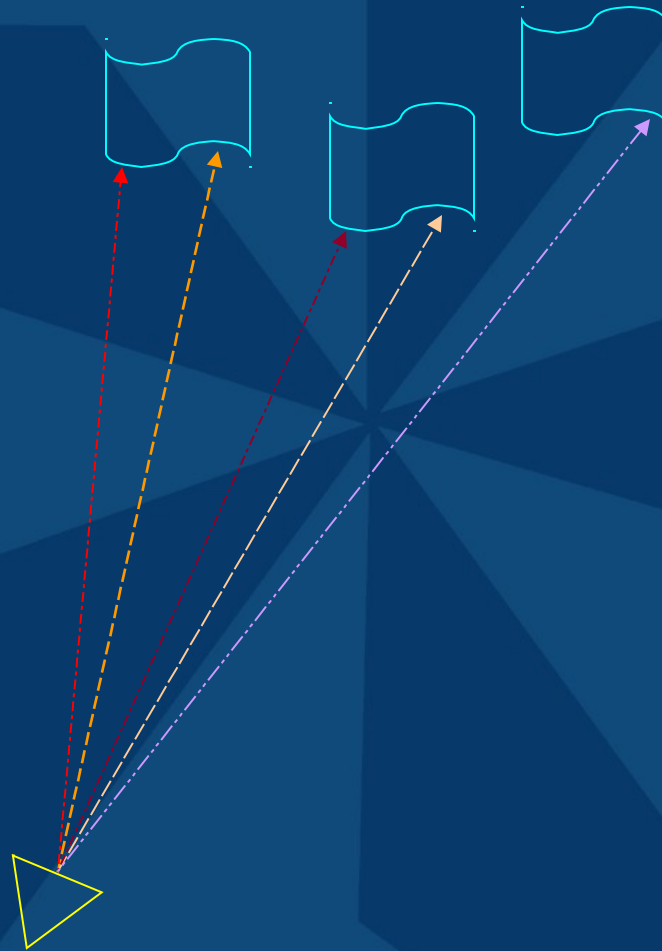
DLP  
Projector  
(1024x768)



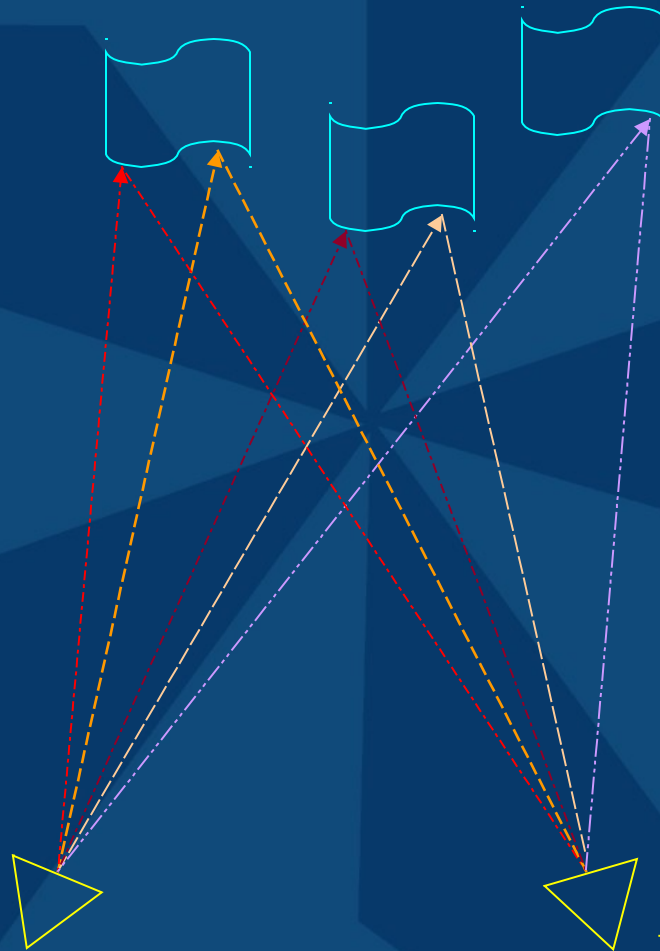
Digital Video  
Camera (1024x1024)



- **Projector sends out a unique signal pattern in each direction**



- **Camera records signals returning from each direction, and analyzes the pattern**



# Advantages/Disadvantages

- **Advantages**

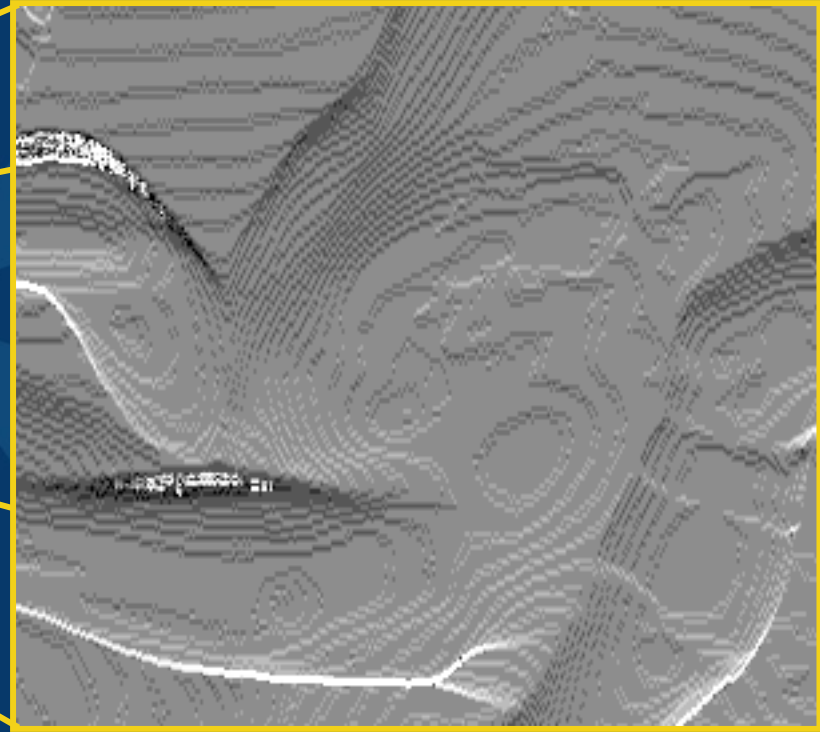
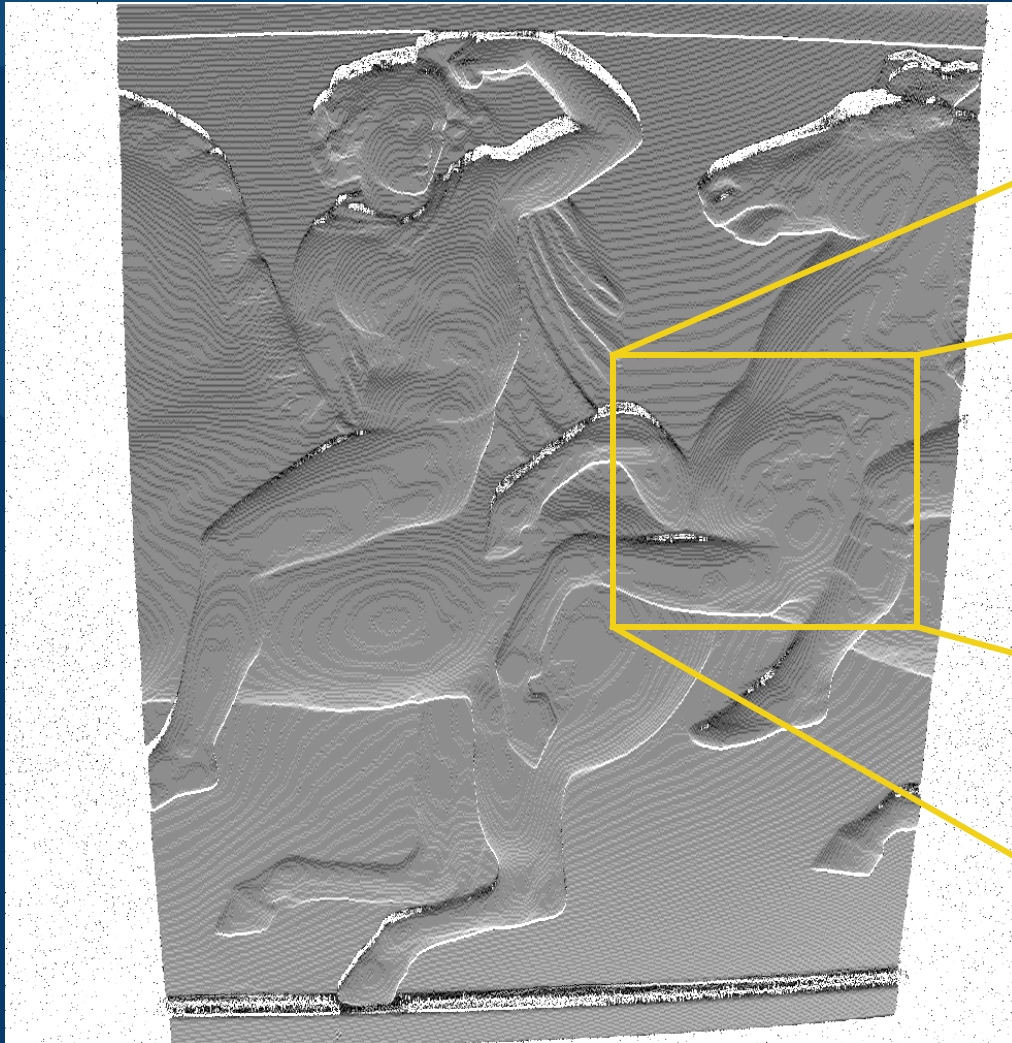
- Cheap (several thousand for the hardware)
- Fast (~15 seconds / 1,000,000 points)
- Accurate
- Can get textures at the same time

- **Disadvantages**

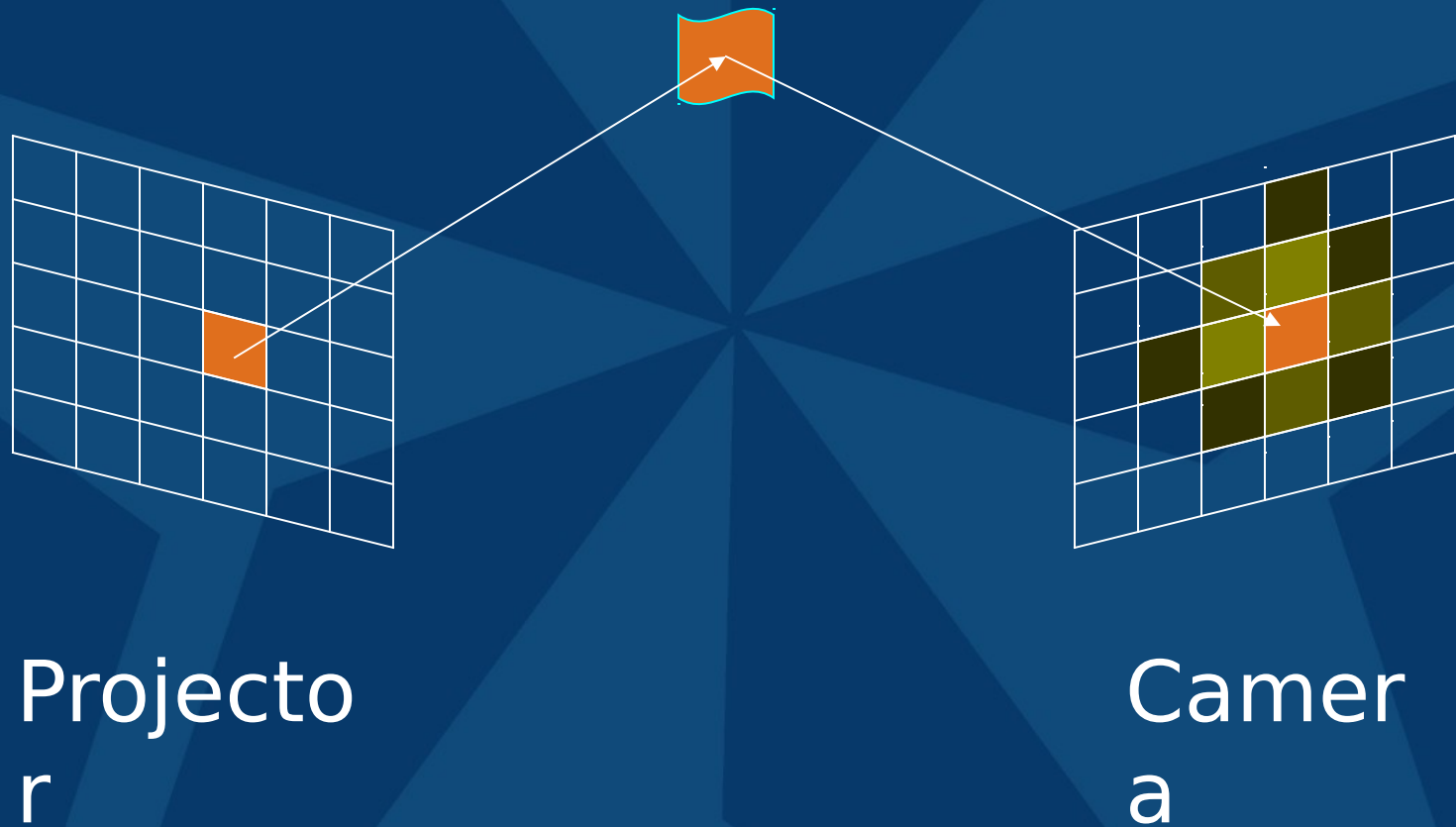
- Hard to scan large objects (more than 8 ft)
- Or in bright light
- Calibration is not easy



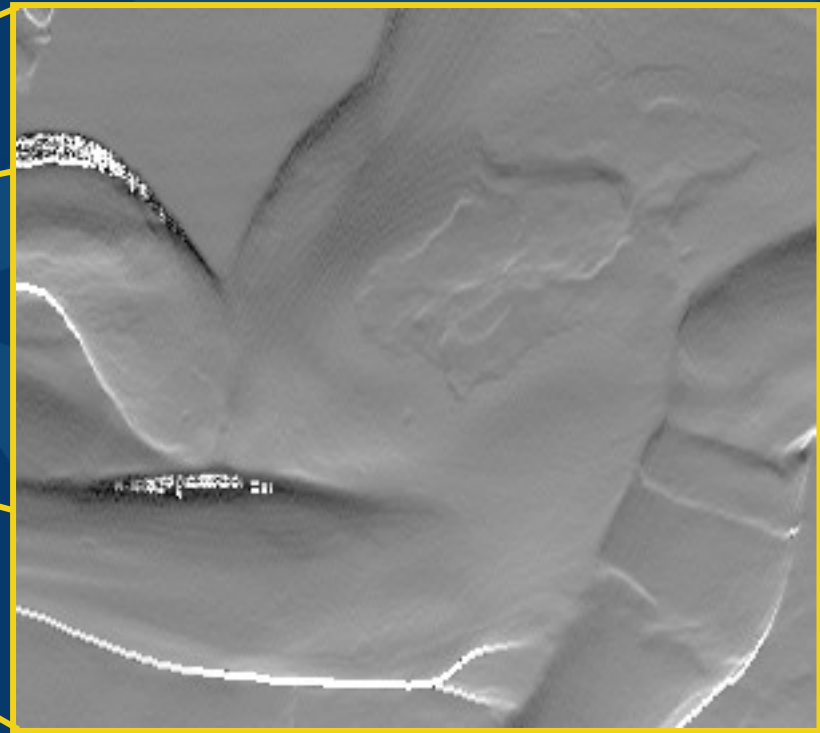
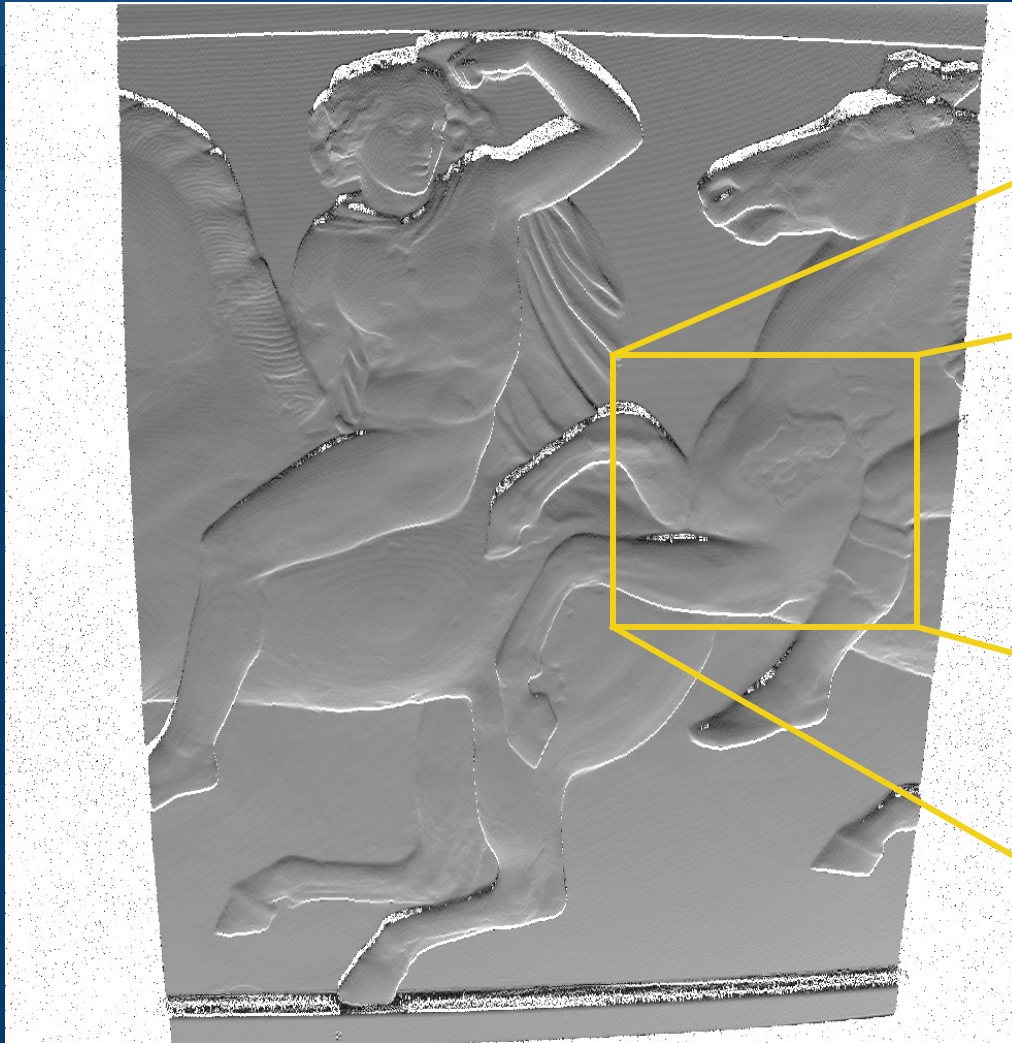
# Pixel Accuracy



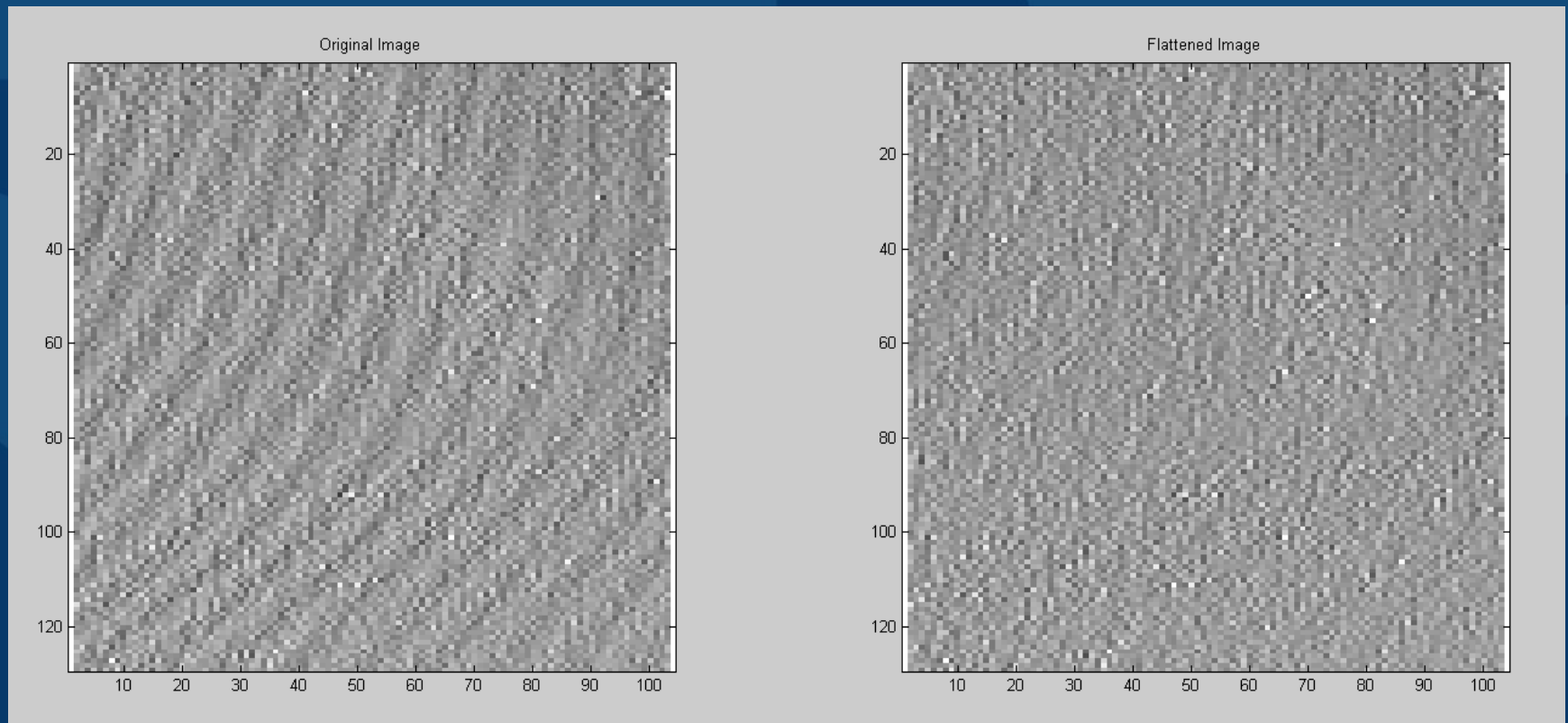
# Pixel Close-up



# Sub-pixel Accuracy



# Sub-pixel Curve Modeling



Chris Tchou Master's Thesis 2002



# 3D Scanning Parthenon Sculptures



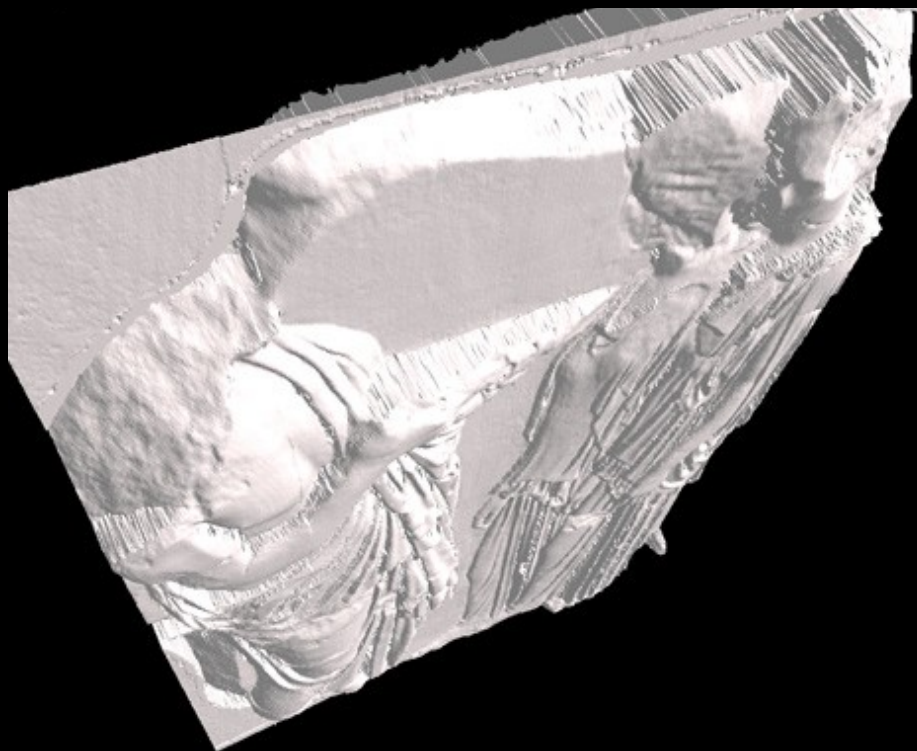
Basel Skulpturhalle, October 2001





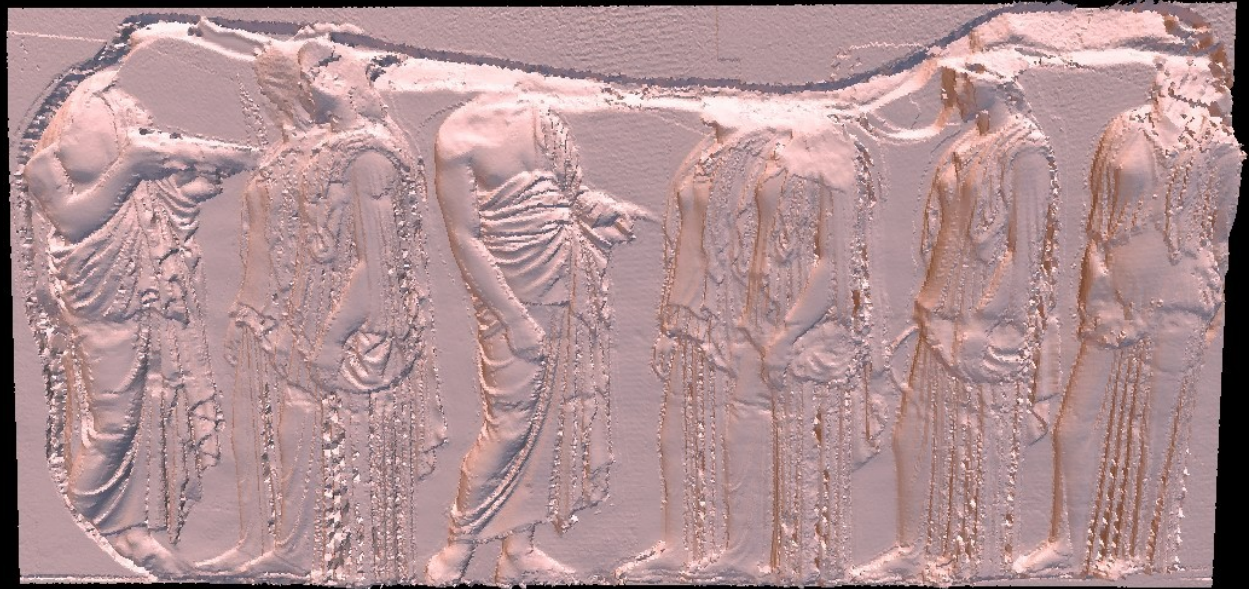
Musee du Louvre, October 2001





# Additional Evidence:

**Drawings can provide additional lost information. How can this be incorporated?**



3D Scan, 2001



Carrey Drawing, 1674



# Scanning Casts:

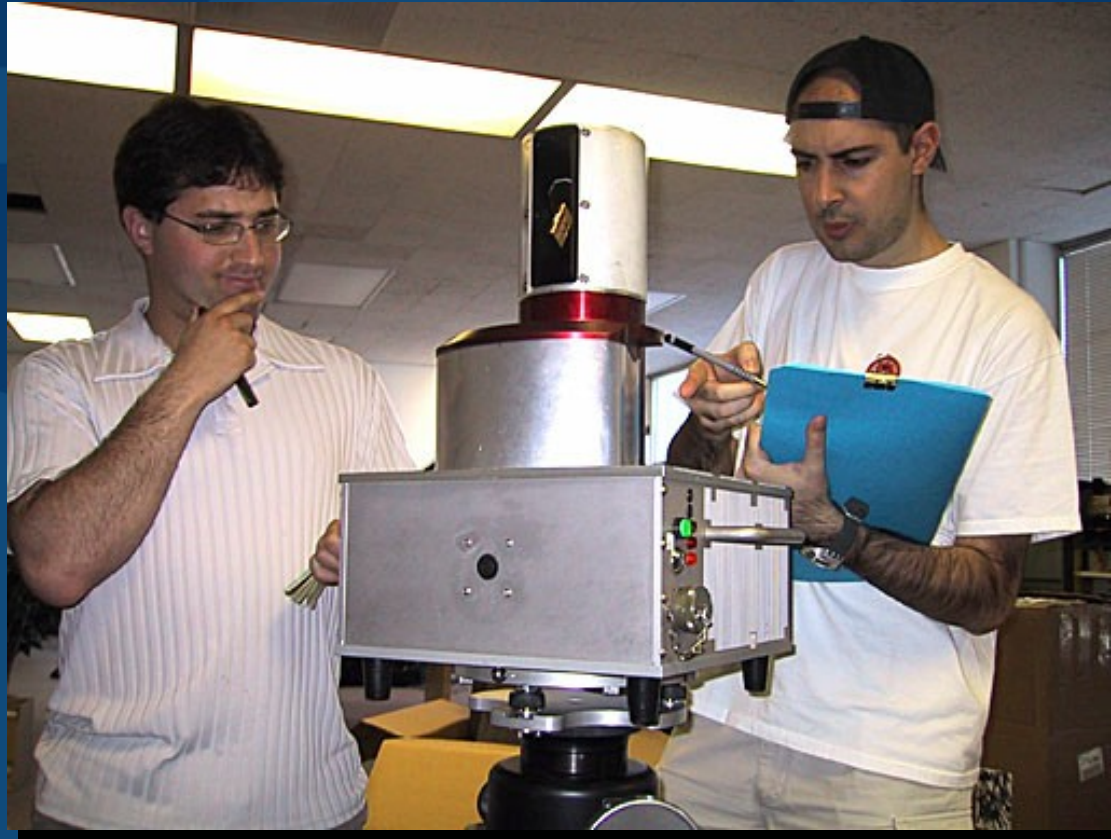
Sometimes in  
better condition  
than originals



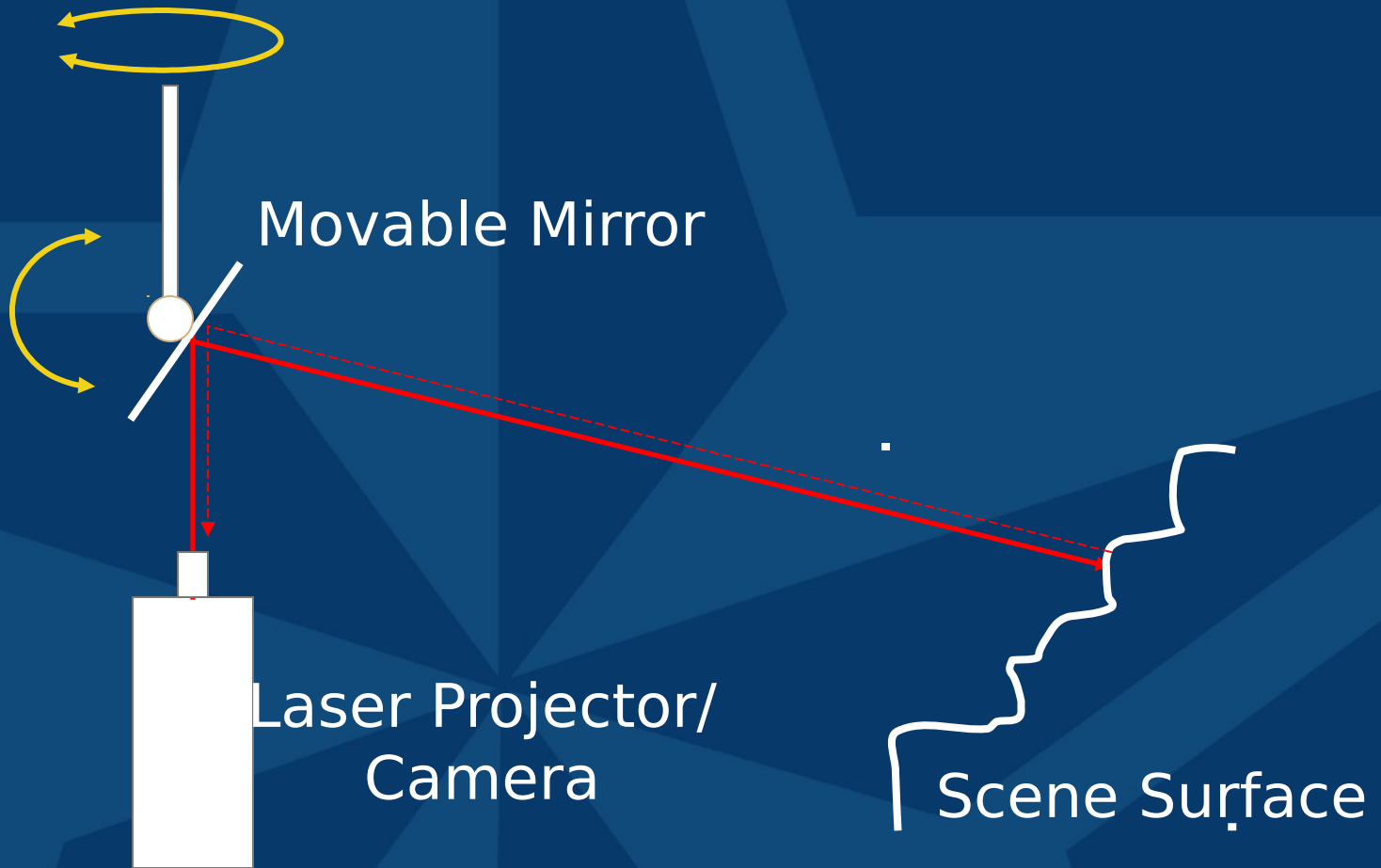


**Scan with and without texture**

# Scanning Environments











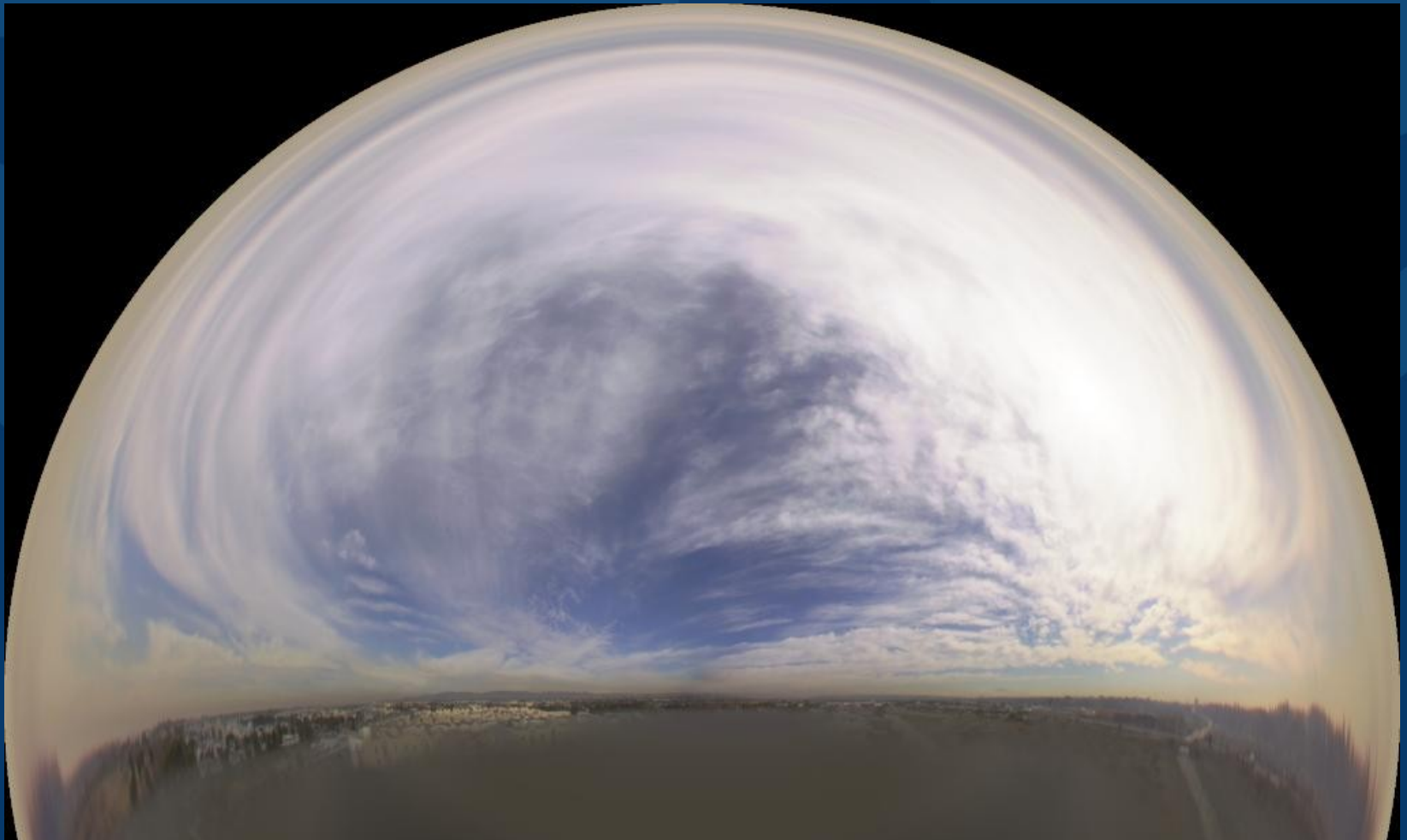
# **Rendering Archaeological Models with Global Illumination and Image- Based Lighting**

# Acquiring Real-World Illumination





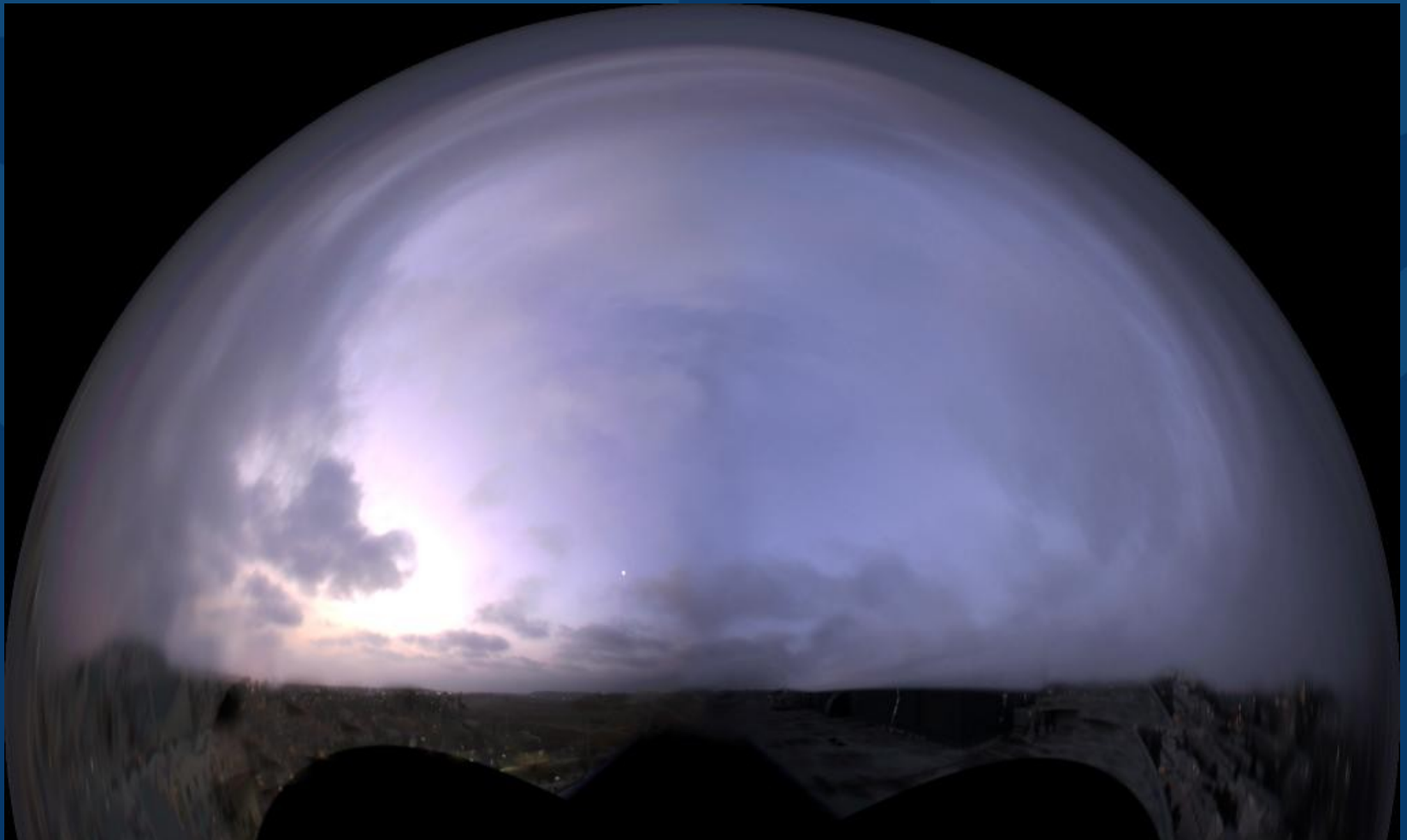
# Outdoor Light Probes



# Outdoor Light Probes

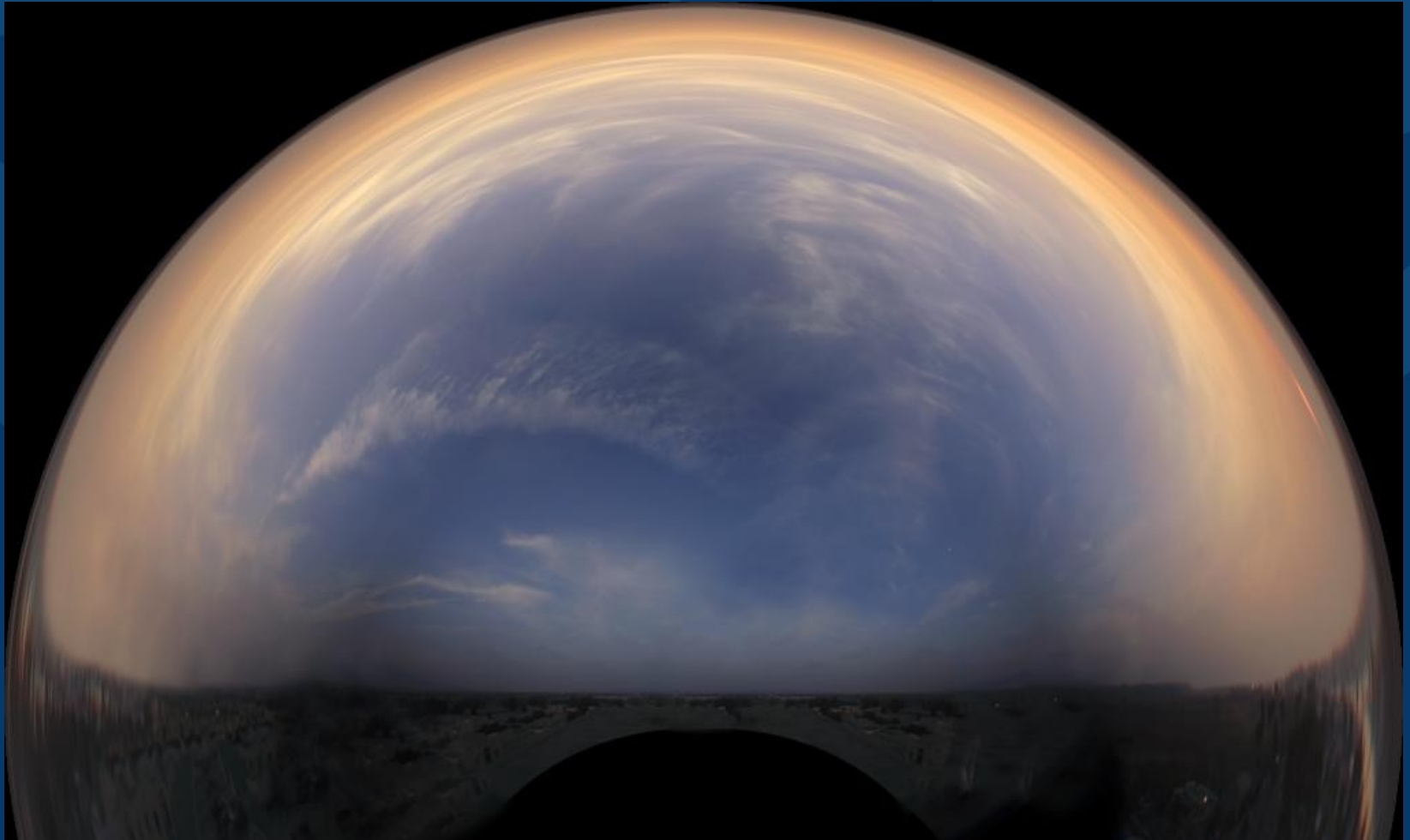


# Outdoor Light Probes



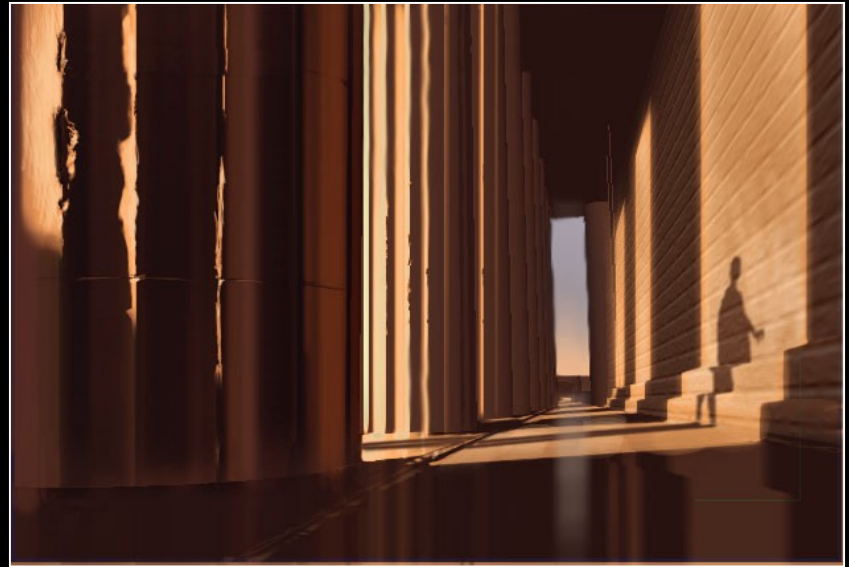


# Outdoor Light Probes





Untextured Model rendered with real-world illumination



Lighting Concept Drawings by Mark Brownlow

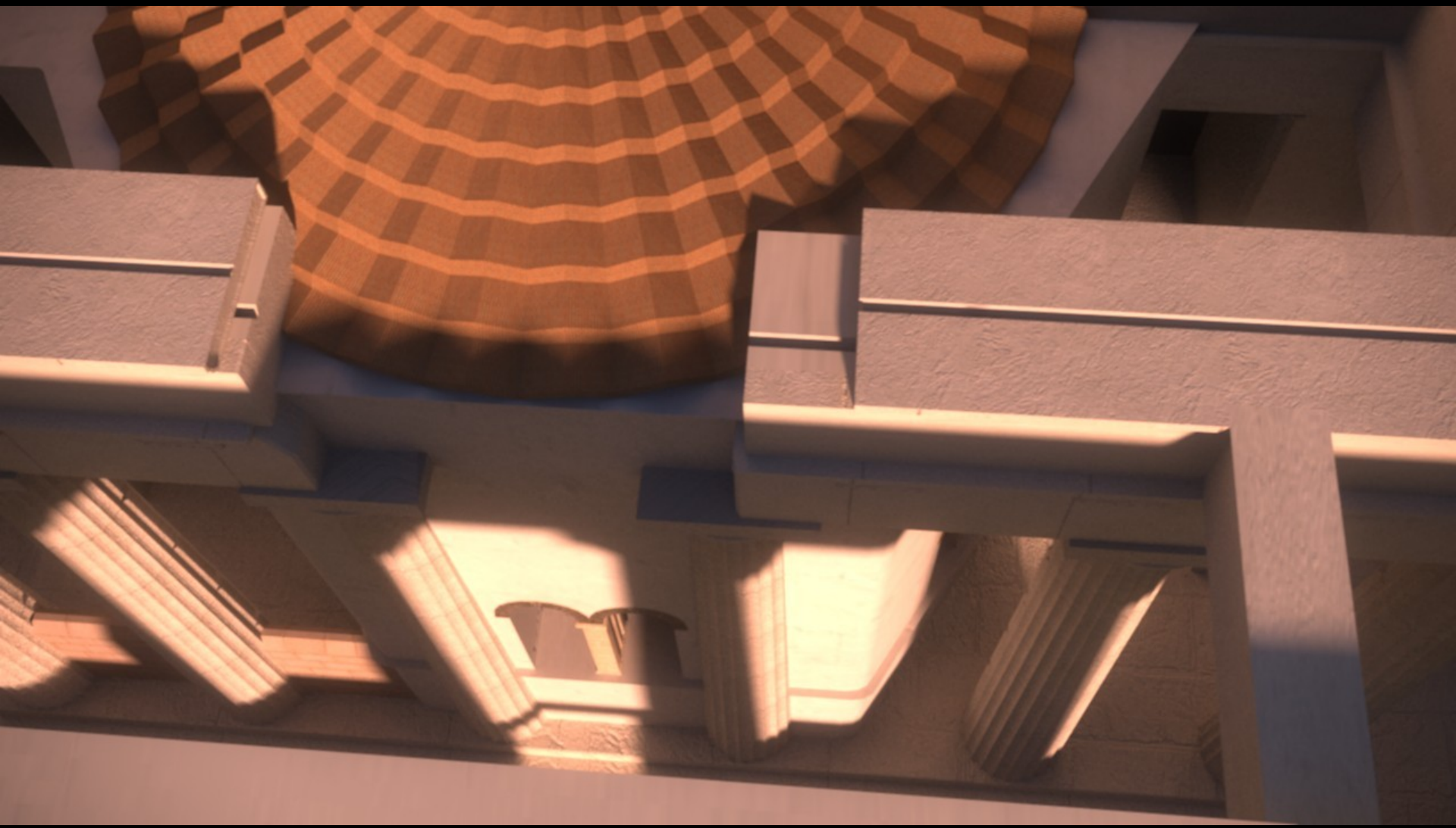


Computer model of Parthenon, c. 1830, illuminated with image-based lighting, Arnold global illumination, depth of





Model of contemporary Parthenon, illuminated by evening light of Marina del Rey, CA



Model of Christian Parthenon, c. 1000AD, showing Apse addition.



Computer model of the Duveen Gallery in the British Museum, site of many of the Parthenon sculptures.









Rendering of a computer scan of a cast of West Panel II of the Parthenon frieze in the Basel Skulpturhalle.



Rendering of a computer scan of the head of a Caryatid cast scanned in the Basel Skulpturhalle.

Modeling and Animation

Brian Emerson  
Craig “X-Ray” Halperin  
Mark Brownlow  
Yikuong Chen  
Diane Suzuki  
Hiroyuki Matsuguma  
Jamie Waese  
Rippling Tsou  
Shivani Khanna  
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Arnold Rendering Software

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Chris Tchou  
Paul Debevec

Scanning Software

Chris Tchou  
Jonathan Cohen  
Fred Pighin

Video Editing

Paul Asplund

3D Scanning made possible by Tomas Lochman of the Basel  
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